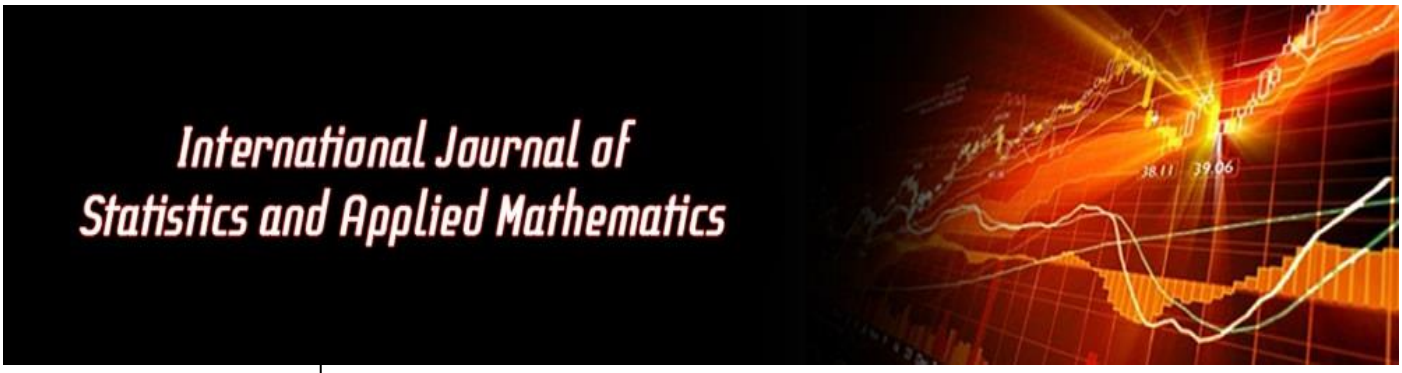

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Farming for the future: A comprehensive study of organic agriculture in India

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Abstract
Organic farming in India, deeply rooted in traditional practices, is experiencing a renaissance driven by concerns over the environmental and health impacts of conventional agriculture. This study presents an overview of organic farming in India, analyzing trends in area, production and export dynamics of organic products. Data from the National Programme for Organic Production (NPOP) and the Agricultural Processed Food Products & Export Development Authority (APEDA) were utilized, with methodologies including a Compound Annual Growth Rate, percentages, and Markov chain analysis to find out the stable markets for organic export from India. Results revealed significant growth in organic farming areas and producers, with states like Madhya Pradesh, Maharashtra, and Rajasthan leading in cultivation and production. Major export destinations include the U.S.A., European Union, and Canada. Markov chain analysis showed that USA, Canada and EU are the most stable markets for India's organic products. The study concludes that organic farming in India holds immense potential and requires continued governmental support overcome challenges. Policy perspectives encompass promoting organic farming zones and simplifying certification processes. The growth in organic farming areas and producers reflects a promising future for sustainable agriculture in India, aligned with global environmental conservation efforts and sustainable development goals.

Keywords: Organic farming, APEDA, NPOP, export dynamics, compound annual growth rate, Markov chain, organic certification, sustainability

Introduction
The historical foundation of organic farming in India lies deeply entrenched within its traditional agricultural practices, which have been cultivated over millennia. These practices have long emphasized the utilization of natural resources and processes to cultivate crops while preserving environmental harmony. In recent years, escalating concerns regarding the adverse environmental and health impacts of conventional farming methods have spurred a burgeoning interest in organic agriculture across the nation. This shift in agricultural ethos has been complemented by governmental recognition and support, materialized through initiatives such as the establishment of organic farming zones and the provision of subsidies for organic inputs (Das *et al*., 2021) [3].

Concomitantly, non-governmental organizations have played a pivotal role in advocating for and disseminating knowledge about the benefits of organic farming practices. Through grassroots efforts, these organizations have endeavored to educate farmers about sustainable agricultural techniques and promote the adoption of organic farming methods (Reganold & Wachter, 2016) [7]. However, despite concerted efforts, organic farming in India faces a myriad of challenges, including inadequate infrastructure, limited market access, and the economic constraints associated with organic inputs (IFOAM, 2008) [9].

Nevertheless, organic farming epitomizes a holistic approach to sustainable development, aligning with the principles espoused by the Brundtland Report of 1987, which emphasizes meeting the needs of the present without compromising the ability of future generations to meet their own (Bandanaa *et al*., 2021) [1]. By nurturing biodiversity, enhancing soil health, and minimizing environmental impact, organic farming emerges as a beacon of hope for a more ecologically resilient agricultural landscape.

Moreover, the global ascendancy of organic farming underscores its significance as a catalyst for sustainable development. With the organic food and drink market experiencing exponential growth worldwide, there is a burgeoning demand for products cultivated through environmentally friendly practices (Willer *et al*., 2022) [9]. Nevertheless, the journey towards widespread adoption is beset with obstacles, including navigating certification processes, enhancing productivity, and accessing markets.

This study provides a comprehensive analysis of the organic farming landscape in India, focusing on key trends in organic farming area, production, and export dynamics. Utilizing data from authoritative sources such as the National Programme for Organic Production (NPOP) and the Agricultural Processed Food Products & Export Development Authority (APEDA), this research employs various analytical methodologies, including Compound Annual Growth Rate (CAGR), percentage analysis, and Markov chain analysis. The primary objective is to identify stable markets for organic exports from India, shedding light on the growth and potential of the organic farming sector in the country.

Data and Methodology

The investigation delves into the potential of organic farming within the Indian context. To conduct this study, an extensive review of literature and reports from international institutes and experts was undertaken. Furthermore, data such as the extent of land under organic cultivation, the number of practitioners engaged in organic farming, the volume of organic produce, and the scale of organic exports were analyzed to elucidate emerging trends in the sector. Secondary data was sourced from reputable publications including the International Federation of Organic Farming Movement (IFOAM), the Research Institute of Organic Agriculture (FiBL) Statistics – European and global organic farming statistics, and the Agricultural Processed Food Products & Export Development Authority (APEDA). Utilizing this data, the subsequent section presents a comprehensive discussion on the current status of organic farming in India. Utilizing simple percentages and graphical representations of data, alongside conducting a Markov chain analysis to assess export performance, comprehensive insights into the current status of organic farming in India are presented in the subsequent section.

An analysis of the structural shifts in organic product exports originating from India was conducted, with a specific focus on understanding the dynamics of market retention and market switching. To gather the requisite data, country-wise export data in terms of quantity spanning from 2012-13 to 2022-23 was collected from the Data provided by the accredited Certification Bodies under National Programme for Organic Production (NPOP) on Tracenet. A critical aspect of this analysis involved estimating the transitional probability matrix, denoted as 'P.' Each element within this matrix, represented as 'P_{ij},' indicated the likelihood that exports would transition from the exporting country 'i' to the importing country 'j' over a defined time period. The diagonal elements of this matrix, 'P_{ii},' held significance in measuring the probability that a specific importing country would maintain its share of imports from the same exporting country in successive periods. In simpler terms, these diagonal elements served as an indicator of the level of loyalty exhibited by an importing country towards a particular exporting country. Conversely, the off-diagonal or transfer probabilities encapsulated the likelihood that the export share of a given exporting country would shift to another destination country as time progressed.

The determination of a country's export share during a specific period 't' was achieved by multiplying the actual export quantities in the preceding period (t-1) by the transition probability matrix. This approach facilitated gaining valuable insights into the intricate patterns and shifts in organic product exports from India across various destination countries over the examined time frame. The average export to a particular country was considered a random variable dependent solely on its past exports to that country, denoted algebraically by Eq. (1):

$$\underset{i=1}{\overset{r}{E_{jt}}} = \sum E_{it-1}P_{ij} + e_{jt} \qquad \text{Eq (1)}$$

E_{jt} = Exports from India to the jth country during the year t.
E_{it}-1 = Exports to the ith country during the year t – 1
P = Probability that exports will shift from the i^{th} country to the j^{th} country
e_{jt} = Error-term which is statistically independent of ejt-1, and
r = Number of importing countries.
The transitional probabilities Pij, which can be arranged in a (c × r) matrix, having following properties:
$0 \leq P_{ij} \leq 1$ and

$$\sum_{i=1}^{n} Pij = 1 \text{ for all } i$$

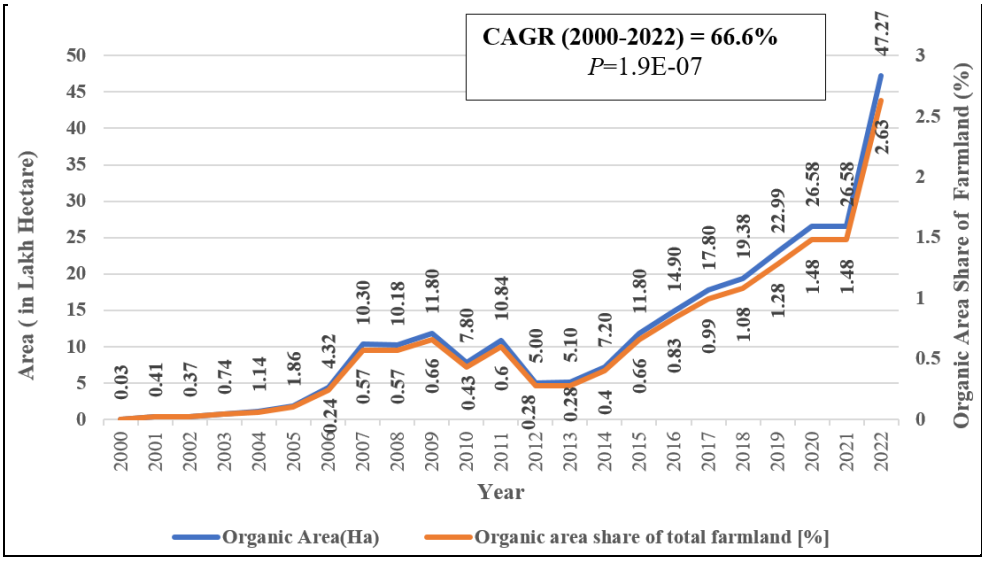
The transition probability matrix was estimated in the linear programming (LP) framework by a method referred to as minimization of mean absolute deviation (MAD); the LP formulation on analysis was stated as per expression

$$\text{Min } O\,P^* + \mathbf{I}_e \qquad (2)$$

Subject to, $XP^* + V = Y\ GP^* = 1\ P^* \geq \phi$

Where,
P* is a vector of the probabilities Pij; O is a null vector;
I is an appropriately dimensional vector of areas; e is the vector of absolute errors (| U |);
Y is the vector of exports to each country; X is a block diagonal matrix of lagged values of Y;
V is the vector of errors, and G is a grouping matrix to add the row elements of P arranged in P* to unity.
P* vectors were arranged to obtain the transitional probability matrix which indicated the overall structure of the transitions that had taken place in the system. Essentially, the transitional probability matrix captures the dynamics of changes in major organic product exports from India.

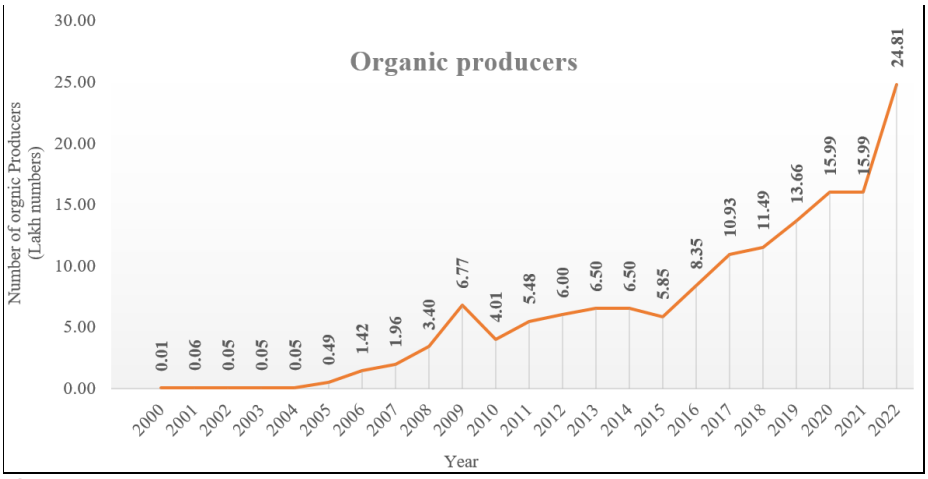
Results and Discussion



***Source*:** FiBL

Fig 1: Trend in Organic Area and Organic Area share (%) in India's total farmland

Since its inception in 2001, the National Programme for Organic Production (NPOP) has steadily increased the area under organic farming practices in India. Figure 1 illustrates the growth of certified organic farming areas in the country, displaying a cyclic trend. In 2000 it was 0.03 lakh hectare, which surged to 11.8 lakh hectares in 2009 before experiencing a decline. However, a notable reversal occurred in 2020 and 2021, with the area under organic farming beginning to rise and peaking at 26.58 lakh hectares and in the next year it was almost doubled i e., 47.27 lakh hectares. This positive growth trend reflects an increasing popularity and adoption of organic farming practices among Indian farmers. Organic area's share of total farmland in India also plotted from 2000 to 2022. The data reveals a gradual increase in the proportion of organic farmland over the years, with the share rising from negligible levels in the early 2000s to 2.63 percent in 2022. The policies, institutions and schemes launched have significantly boosted organic farming in India, rendering growth of various agroecological zones in the country, attributing to large areas under organic certification, including Madhya Pradesh, Rajasthan Maharashtra, Gujarat, Karnataka, Odisha, Sikkim, and Uttar Pradesh (Manida & Nedumaran, 2021) [6]. Notable increases occurred between 2006 and 2009, and again from 2014 onwards, with more modest growth rates in other years. This indicates a growing adoption of organic farming practices in India, albeit from a relatively small base compared to conventional farming. The Compound Annual Growth Rate (CAGR) for organic area in India from 2000 to 2022 is 66.6 percent. This indicates a significant annual growth rate in organic farming practices over the specified period.



***Source*:** FiBL

Fig 2: Trend in organic Producers (Lakh Numbers) in India from 2000 to 2022

Figure 2 illustrates the exponential growth in the number of organic producers in India. In 2000, there were thousand organic producers, a number that surged to 6.7 lakh in 2009 and further to 24.81 lakh by 2022. This rapid increase can be attributed to India's substantial population, as well as the fact that 85 percent of its farmers are classified as small and marginal, owning less than 2 hectares of land (Agriculture Statistics at a Glance, 2021). Organic farming is particularly appealing to these farmers due to its lower costs and higher profitability. Consequently, these factors have led to a swift adoption of organic farming practices among farmers in India.

Table 1: Top ten state wise oragnic area under cultivation and their percentages to total area (2022-23)

Sl. No	State Name	Organic Area (In 000' Ha)	% to total Organic area	Total Area (organic + convesrion) (In 000' Ha)	% to Total Area (In Ha)
1.	Madhya Pradesh	686.21	38.9	1517.38	28.1
2.	Maharashtra	258.64	14.7	1284.31	23.8
3.	Gujarat	84.40	4.8	935.93	17.4
4.	Rajasthan	216.44	12.3	580.68	10.8
5.	Odisha	77.95	4.4	195.08	3.6
6.	Uttarakhand	32.63	1.8	98.39	1.8
7.	Telangana	7.29	0.4	84.47	1.6
8.	Karnataka	44.34	2.5	82.02	1.5
9.	Sikkim	75.45	4.3	75.48	1.4
10.	Uttar Pradesh	52.42	3	68.01	1.3
	total	1764.68		5391.79	

***Source*:** APEDA

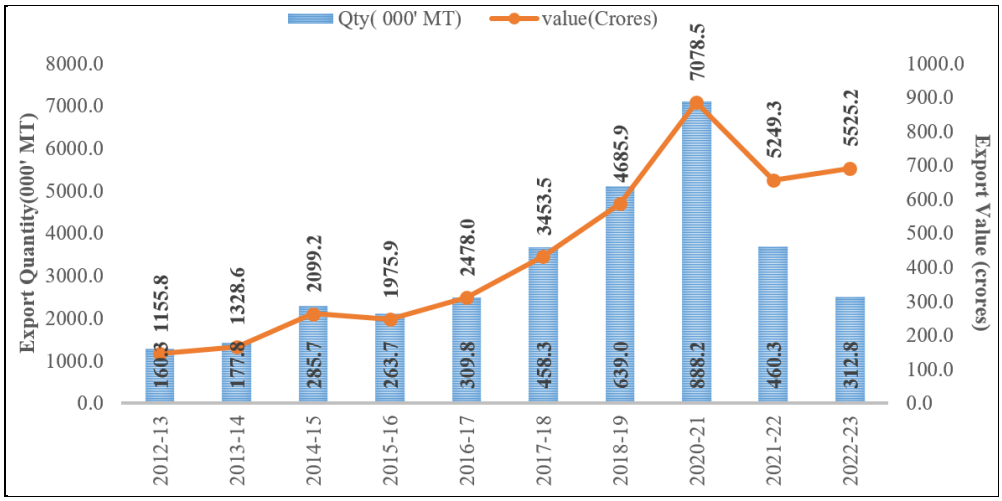
The table 1 presents key insights into the top ten states in India for organic cultivation in 2022-23. Madhya Pradesh leads with 686.21 thousand hectares, accounting for 38.9percent of the total organic area and 28.1percent of the total area (organic + conversion). Maharashtra follows with 258.64 thousand hectares (14.7 percent of organic area, 23.8 percent of total area), and Gujarat ranks third with 84.40 thousand hectares. Rajasthan, at 216.44 thousand hectares, contributes 12.3percent to the organic area and 10.8 percent to the total area. Odisha has 77.95 thousand hectares 3.6percent of total area), while Uttarakhand has 32.63 thousand hectares (1.8percent of organic area, 1.8percent of total area). Telangana's organic area is 7.29 thousand hectares (0.4percent of organic area, 1.6 percent of total area), and Karnataka's is 44.34 thousand hectares (2.5percent of organic area, 1.5 percent of total area). Sikkim has 75.45 thousand hectares (4.3percent of organic area, 1.4percent of total area). The total organic area for these states is 1764.68 thousand hectares, contributing to a total area of 5391.79 thousand hectares.

Table 2: Top ten state wise oragnic production and their percentages to total production (2022-23)

Sl. No.	State Name	Organic Production (In 000' MT)	Percent to total Organic Production	Total Production (conversion + organic) (000' MT)	Percent to total Production
1.	Madhya Pradesh	738.2	27.7	825.63	27.96
2.	Maharashtra	724.9	27.21	790.33	26.76
3.	Rajasthan	311.2	11.68	322.97	10.94
4.	Karnataka	237.1	8.9	237.09	8.03
5.	Uttar Pradesh	215.5	8.09	217.52	7.37
6.	Gujarat	90.0	3.38	139.73	4.73
7.	Odisha	65.0	2.44	130.08	4.41
8.	Jammu &Kashmir	50.2	1.89	50.23	1.70
9.	Uttarakhand	44.0	1.65	43.95	1.49
10.	Kerala	42.7	1.6	42.73	1.45
	Total	2664.7	100	2952.93	100

***Source*:** APEDA

The table outlines the top ten states in India for organic production in 2022-23, highlighting their respective percentages of total organic production and total production (conversion + organic). Madhya Pradesh leads with 738.2 thousand metric tons (MT), accounting for 27.7 percent of total organic production and 27.96 percent of total production, followed closely by Maharashtra with 724.9 thousand MT (27.21 percent of organic production, 26.76 percent of total production). Rajasthan ranks third with 311.2 thousand MT, contributing 11.68 percent to organic production and 10.94 percent to total production. Karnataka and Uttar Pradesh follow with 237.1 thousand MT (8.9 percent of organic production, 8.03 percent of total production) and 215.5 thousand MT (8.09 percent of organic production, 7.37 percent of total production) respectively. Gujarat, Odisha, Jammu & Kashmir, Uttarakhand, and Kerala complete the top ten, each contributing varying percentages to both organic and total production. Overall, these states contribute a total of 2664.7 thousand MT to organic production, and 2952.93 thousand MT to total production. The graph highlights the Indias oragnic products export quantity thousand metric tonnes and value (Crores) from 2012-13 to 2022-23. The fluctuation in the quantity of organic products exported from India, ranging from 160.3 thousand metric tonnes in 2012-13 to 888.2 thousand metric tonnes in 2020-21, can be attributed to changing demand patterns in export markets, driven by consumer awareness, health consciousness, and disposable income levels (Gupta & Prakash, 2016) [4]. In 2021-22, the quantity dropped to 460.3 thousand metric tonnes from the previous year's 888.2 thousand metric tons, indicating a significant decrease in exports. However, there was a further decline in 2022-23, with exports totaling 312.8 000' MT. This downward trend may be influenced by various factors, including changes in international market demand, fluctuations in production, and global economic conditions.



***Source*:** Data provided by the accredited Certification Bodies under NPOP

Fig 3: Trend in India's Organic Products Export quantity (000' MT) and value (Crores) from 2012-13 to 2022-23

Table 3: Share of Organic Export from India to different countries (2013-14 - 2022-23)

Countries	Percentage Share in Total Export Quantity
U.S.A.	44.11
European union	31.97
Canada	12.12
Others	6.26
Switzerland	1.37
Korea republic	0.41
Israel	0.40
Australia	0.39
New Zealand	0.29
U.A.E.	0.11
Sri Lanka	0.07
Others	2.51

***Source*:** Data Provided by the accredited Certification Bodies under NPOP

The table presents the percentage share of organic exports from India to different countries from 2013-14 to 2022-23. The United States leads with a significant share of 44.11 percent, followed by the European Union with 31.97 percent and Canada with 12.12 percent. Other countries collectively account for 6.26 percent of the total export quantity, while Switzerland, Korea Republic, Israel, Australia, New Zealand, U.A.E., and Sri Lanka each have smaller shares ranging from 0.11 percent to 1.37 percent. Overall, these countries make up 97.49 percent of India's total organic export quantity, with the remaining 2.51 percent distributed among other nations.

Table 4: Transitional Probability Matrix for Organic Products Export from India

Countries	EU	U.S.A.	Canada	Switzerland	New Zealand	Australia	U.A.E.	others
EU	0.462	0.324	0.188	0.018	0.002	0.004	0.002	0.000
U.S.A.	0.318	0.597	0.000	0.000	0.000	0.001	0.001	0.084
Canada	0.000	0.496	0.470	0.026	0.008	0.001	0.000	0.000
Switzerland	0.000	0.000	0.858	0.142	0.000	0.000	0.000	0.000
New Zealand	0.000	0.000	0.000	0.431	0.000	0.569	0.000	0.000
Australia	0.000	0.000	0.850	0.000	0.150	0.000	0.000	0.000
U.A.E.	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
others	0.637	0.000	0.000	0.049	0.007	0.008	0.003	0.296

***Source*:** Authors Calculations

The structural changes in organic product exports from India were analyzed by estimating the transitional probability matrix using a stochastic model (Markov chain). The matrix, presented in Table 3, considered major destinations as the U.S.A., the European Union, Canada, Switzerland, Australia, New Zealand, U.A.E., Sri Lanka, and grouped the remaining countries under the 'Others' category.

The diagonal elements of the matrix indicate the probability of retaining export share within the same country over successive time periods, while the off-diagonal elements indicate the probability of exports shifting from one country to another over time.

The results in Table 4 show that the highest retention rate was observed in the U.S.A. (59.7 percent), followed by Canada (47 percent), the EU (46.2 percent), Switzerland (14.2 percent), and others (29.6 percent). These findings suggest that the U.S.A. was the most stable market among the major importers of Indian organic produce, with a retention probability of around 60 percent. However, the U.S.A. also lost 31.8 percent of its share to the EU, 8.4 percent to other countries and 8.4 percent to countries not included in the major importer list.

Canada was the second most stable market, with a retention rate of 47 percent, but it lost 49.6 percent of its share to the

U.S.A. and 2.6 percent to Switzerland. The EU was the next stable market, with a retention rate of 46.2 percent, but it lost 32.4 percent of its share to the U.S.A. and 18.8 percent to Canada. New Zealand, Australia, and the U.A.E. were found to be the most unstable markets, with zero retention, and the major share of their exports shifted other countries like Australia, Switzerland, USA, Canada and UAE.

Conclusion

The trajectory of organic farming in India reflects a promising future, marked by significant growth in organic cultivation areas, the number of organic producers, and organic product exports. The historical roots of organic farming in traditional agricultural practices, combined with escalating concerns about the environmental and health impacts of conventional farming, have led to a widespread shift towards organic agriculture. Governmental support and initiatives, coupled with efforts from non-governmental organizations, have further bolstered this transition. The analysis of the top states for organic cultivation and production provides valuable insights into the regional distribution and contribution to the organic farming sector. States like Madhya Pradesh, Maharashtra, and Rajasthan emerge as leaders in organic farming, showcasing the diversity and scale of organic cultivation across India. Furthermore, the organic product exports demonstrates India's position in the global organic market. The country's exports to major destinations like the U.S.A., European Union, and Canada highlight the growing demand for Indian organic products internationally. To capitalize on the momentum of organic farming in India, the government should continue supporting initiatives such as organic farming zones and subsidies. Investment in infrastructure, promotional campaigns, and training programs can boost adoption. Streamlining certification processes and investing in research can further enhance the sector's growth. Collaborating with international partners can expand market access for Indian organic products, fostering sustainable agricultural practices.

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